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PETROLEUM ASSOCIATION FOR CONSERVATION OF THE CANADIAN ENVIRONMENT
ASSOCIATION PÉTROLIÈRE POUR LA CONSERVATION DE L'ENVIRONNEMENT CANADIEN

PACE Report No. 87-1

GUIDELINE SPECIFICATION FOR THE IMPRESSED CURRENT METHOD OF CATHODIC PROTECTION OF UNDERGROUND PETROLEUM STORAGE TANKS

"Working for a Better Environment"

GUIDELINE SPECIFICATION FOR THE IMPRESSED CURRENT METHOD OF CATHODIC PROTECTION OF UNDERGROUND PETROLEUM STORAGE TANKS

PACE REPORT No. 87-1

(Update of PACE Report No. 79-4)

Prepared for

Petroleum Association for Conservation
of the Canadian Environment (PACE)
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Ottawa, Ontario K1P 5H9

Prepared by

Corrosion Service Company Limited

FEBRUARY 1987

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PART 1A - LIST OF DRAWINGS

Drawing No.	Revision No.	Description
D-1448-01	2	Cathodic Protection Plan
D-1448-02	4	Cathodic Protection Details and Electrical Schematic

PART 1.0 - GENERAL

1.1 INTERPRETATION

a. "Consultant" means an authorized corrosion engineering consultant.

b. "Owner" means the particular Oil Company for whom these works are authorized.

c. "Contractor" means company undertaking the works.

d. "Corrosion Specialist" means an individual who is a Corrosion Specialist in cathodic protection as accredited by the National Association of Corrosion Engineers (NACE).

e. This standard is intended to be applied to existing underground tankage for the cathodic protection by the impressed current method of external surfaces of tanks storing flammable and combustible liquids.

1.2 SCOPE OF WORK

a. Contractor to supply all labour, materials, equipment and transportation to complete the works as outlined herein and shown on the drawings and as necessary by evidence.

b. Works shall include but not be limited to the following:

(i) Determination of material requirements and location as per Section 2.0.

(ii) Supply and installation of anodes, cable, rectifier, reference electrodes and attendant equipment complete with supply of A.C. power to the rectifier unit as per Section 3.0 and 4.0.

(iii) Inspection and commissioning of works as per Section 5.0.

1.3 WORK EXCLUDES

a. Those items as evidenced on the "Owner's" tender document.

1.4 RELATION BETWEEN PLANS & SPECIFICATIONS

a. Where a discrepancy exists between plans and specifications the specifications shall have priority.

b. The "Consultant" shall be permitted to interpret the intent of the plans and specifications where a discrepancy exists.

c. The "Contractor" shall not profit from errors or omissions in the plans or specifications.

d. Designations of trade name defines the quality and performance of materials and shall not be interpreted as disapproval of other manufacturers. A material shall be deemed equal only with the written approval of the owners' representative, based on the advice of a "Corrosion Specialist".

1.5 WORKMANSHIP

a. Design (Section 2.0) and Inspection and Commissioning (Section 5.0) shall be performed by a Corrosion Specialist or his authorized representative.

b. All installation work shall be performed according to instructions given herein using the most suitable equipment and under the direct supervision of a Corrosion Technician or Technologist as certified by the N.A.C.E.

1.6 GUARANTEE

a. The contractor shall provide a written guarantee against any defect for a period of one year from the commencement of satisfactory operation of the cathodic protection system.

b. All repairs or replacements, as well as repairs to damage to other works caused by a defect in the work during the guarantee period shall be entirely at the expense of the Contractor.

c. Neither field inspection nor approval of substitute materials, nor final acceptance of the work shall free the Contractor from responsibility for defective workmanship or materials.

1.7 HANDLING AND STORAGE

a. Materials shall be stored so as to prevent injury to persons and to prevent the delay of work by others.

b. All materials which can be damaged by exposure to the elements must be stored in a clean and dry enclosure.

PART 2.0 - DESIGN

2.1 GENERAL

a. A registered professional engineer certified as a Corrosion Specialist shall determine rectifier capacity and anode arrangement for the following situations:

(i) the total current requirements exceed 12 amps.

(ii) the tanks are not parallel in the axial direction.

(iii) the tankage is subject to stray current corrosion as a result of the operation of a D.C. transit system.

b. Where one or more of the tanks was previously installed in accordance with the U.L.C. - S603.1 standard for "Galvanic Corrosion Protection Systems for Steel Underground Tanks for Flammable and Combustible Liquids", the tank(s) must be electrically bonded to the remaining tanks. The number and arrangement of anodes shall ensure that each 603.1 tank has a minimum of two anodes of appropriate length, typically positioned as indicated in the detail for single tanks. In addition all electrically isolated piping must be electrically bonded to the rectifier negative header system.

c. A notice shall be placed in a conspicuous location adjacent to the disconnecting means for all submersible pumps, dispensers or other electrical apparatus which is connected to the cathodically protected structures stating "Caution Cathodic Protection must be turned off when replacing dispensers, pumps or modifying the piping associated with cathodically protecting structures in order to reduce the chance of incendive sparks."

d. An explosion proof seal is required in all dc conduit risers immediately above grade.

2.2 RECTIFIER

a. Rectifier shall be the automatic potential controlled type which is also capable of operating in the constant current mode.

b. The rectifier output voltage shall be limited to 50 V.

c. Rectifier current capacity shall exceed the summation of the individual tank current requirements as in Table No. 1.

TABLE NO. 1 CATHODIC PROTECTION CURRENT REQUIREMENTS

Tank Size		Current (Amperes)
1,000 IG	(5,000 l)	0.6
3,000 IG	(15,000 l)	1.2
5,000 IG	(25,000 l)	1.6
7,000 IG	(35,000 l)	2.0
10,000 IG	(50,000 l)	2.6

FOR OTHER SIZES USE THE FOLLOWING FORMULA

$$IR = \left(\frac{\text{Tank Capacity (IG)}}{2000} \times 0.4 + 0.6\right) \text{ amperes}$$

2.3 ANODE REQUIREMENTS

a. Anode location and length shall be determined by reference to the standard arrangement as shown on drawing D-1448-01 Revision 2.

b. Where more than 3 tanks are arranged in parallel as in the standard arrangements, the anode arrangement is repeated accordingly.

c. An anode must be located between tanks regardless of tank size.

2.4 ZINC REFERENCE ELECTRODE REQUIREMENTS

a. A zinc reference electrode is required to be located between all axially parallel tanks. Where more than one reference is installed a selector switch shall be installed in the reference circuit of the indicating meter so that each reference may be read independently.

PART 3.0 - MATERIALS

3.1 ANODES

a. Anodes shall be platinum clad, copper cored niobium wire having a minimum overall diameter of 0.062" (1.5 mm) with a minimum of 100 micro-inches (2.5 microns) of platinum and a minimum niobium thickness of 6.9 mils (170 microns).

b. Anode wire shall be centered in a metallic tubing having a minimum ID of 5.0 cm and surrounded with anode backfill (Section 3.6).

3.2 RECTIFIER

a. Rectifiers shall be of the potential controlled, air cooled, full wave, isolated output type having a thermal overload circuit designed to turn the rectifier off if the internal temperature at any location exceeds 80°C.

b. Rectifier when mounted out-of-doors, shall have a weather proof enclosure equal to CSA Type 3.

c. Rectifier shall be suitable for 110V. single phase ac input.

d. Rectifier shall have an indicating meter having a minimum input impedance of 20,000 ohms per volt for an analog meter or 10 M ohm for a digital meter which is capable of indicating tank potential with respect to $Cu:CuSO_4$.

e. Rectifier shall have external operating lights which indicate satisfactory operation above a minimum tank potential, loss of dc output, or other fault condition.

f. Rectifier shall be CSA approved.

g. Rectifier shall have a non-resetable 115V. ac elapsed time indicator with 99,999 hour capacity. A battery powered downtime counter of the same hour capacity is an optional alternative.

h. Rectifier shall have metering for dc output current and voltage.

i. Rectifier output voltage rating shall be a minimum of 24 up to a maximum of 50 volts and shall be continuously adjustable or adjustable over a minimum of 20 steps.

3.3 CABLES

a. Positive header cables shall be AWG #8/7 strand RWU-90 with red insulation.

b. Structure cables shall be AWG #8/7 strand RWU-90 with black insulation.

c. Reference electrode cable shall be AWG #12/7 strand RWU-90 with white insulation.

d. Anode cables which connect anode wire to the positive header cable shall be AWG #12/7 strand RWU-90 with red insulation.

3.4 ZINC REFERENCE ELECTRODE

a. Electrode material shall be zinc alloy as specified by ASTM B-418-73 and shall be a minimum of 12" (300 mm) long by ½" (12 mm) diameter.

b. The zinc electrode shall be silver soldered to AWG#12/7 strand RWU-90 cable and the connection shall be insulated using a heat shrinkable plastic.

c. Zinc electrode assembly shall be centrally located in a wettable cardboard container having a minimum overall diameter of 2" (50 mm) and the cylinder shall be filled with the following backfill mixture by volume:

77 ± 1% Gypsum
15 ± 1% Bentonite
8 ± 1% Anhydrous Sodium Sulphate

3.5 CONDUIT

a. Below grade dc conduit shall be rigid PVC.

b. Above grade dc conduit shall be rigid conduit.

3.6 ANODE BACKFILL

a. Anode backfill shall be calcined petroleum coke breeze such as 'Loresco' type DW as manufactured by C.E. Equipment Company or equal.

b. Coke breeze shall have a bulk density greater than 70 lbs. per cubic foot (1121 kg/m^3).

c. Coke breeze granular size shall be such that 100% passes through a #16 mesh.

3.7 MISCELLANEOUS

a. Heat Shrinkable sleeves shall be Raychem #WCSF and #TCS with Type 'A' sealant or equal.

b. Crimped copper connector for anode cable-to-header splices shall be Thomas & Betts 'C' tap #54710 and #54715 or equal.

c. Insulating pads shall be polyethylene-backed bitumen catalogue #AC 5x7 as supplied by Thomas & Betts or equal.

d. Ground clamps shall be catalogue #GM by Thomas & Betts or equal.

e. Pipeline grade mastic shall be Tapecoat TC or equal.

f. Neoprene tape and polyethylene tape shall be in either 1" (25 mm) or 3/4" (19 mm) widths.

g. Crimped copper connectors for anode-to-anode cable splices shall be catalogue #26180 as manufactured by Erico Products Incorporated or equal.

h. Buried utility tape shall be 'Westline' cat. no. NA-1268 Yellow labeled 'Buried Electric Line Below.'

PART 4.0 - INSTALLATION

4.1 PRELIMINARY ELECTRICAL CONTINUITY SURVEY

a. Before installation begins an electrical continuity test must be conducted in order to locate isolated piping and tankage.

b. Place a reference electrode over one of the tanks and measure the potential with the negative terminal of a high impedance voltmeter connected sequentially to all tanks by probing through the fill pipe, all fuel piping by connecting at the dispenser upstream of the union, all vent piping at exit from grade, all fill piping and electrical ground at the service electrical panel. Any potential difference between one structure and electrical ground of greater then 10 mV may indicate an electrically discontinuous structure. All structures identified as electrically discontinuous in this test must be electrically bonded directly or indirectly to the negative terminal of the rectifier.

c. Connection to a ULC 603.1M tank can be made using the existing test lead if it can be located and verified as electrically continuous or alternatively by excavating and exposing one of the tank lifting lugs, drilling a 9/32" (7 mm) Ø hole in the lug and attaching a Burndy KPA4C connector to the lug with a 1/4" (6 mm) Ø nut and bolt.

d. Record survey data on Table No. 3.

4.2 ANODES

a. Anodes shall be installed at locations indicated in the standard drawings.

b. Anodes shall be installed in a vertical hole having a minimum diameter of 2" (50 mm) to a minimum depth of 1/8 the tank diameter below the tank bottom. When an anode is to be placed between two tanks of differing elevation, the anode depth will be determined by the deepest tank.

c. Anodes shall not be installed closer than 12" (300 mm) to vent, fill or supply piping.

4.3 BELOW GRADE SPLICES

a. General

Cable splices shall be made a minimum of 6" (150 mm) below grade.

b. Anode-to-Cable Splices

(i) The anode cable shall be connected to the anode using a crimped and soldered copper sleeve.

(ii) This connection shall be sealed using a heat shrinkable sleeve having a minimum length of 6" (150 mm) positioned so that a minimum of 2" (50 mm) of anode and 4" (100 mm) of anode lead are encapsulated.

c. Anode Cable-to-Positive Header Cable

(i) The anode cable shall be connected to the positive header cable using a compression type copper connector. This connection shall be soldered.

(ii) The connection shall be taped with a minimum of two layers of neoprene rubber tape, then an insulating pad shall be formed around the neoprene and adjacent anode and cable. Polyethylene electrical tape shall be taped around the insulating pad to obtain a uniform minimum thickness of 20 mils (.5 mm).

d. Cable Repairs or Extensions

(i) Sections of anode header cable shall be spliced as in Section c(ii).

(ii) Nicks or cuts in the anode header cable insulation shall be repaired in a similar manner.

(iii) Zinc reference electrode cable shall be repaired as in 4.3 d, (i), (ii), and (iii).

e. Structure Connections

(i) The negative header cable shall be attached to the vent or suction lines using ground clamps.

(ii) Where more than one pipe line exists all pipes shall be bonded together.

(iii) Pipe shall be filed to bright metal finish prior to tightening ground clamp to pipe.

(iv) Ground clamp, pipe and cable connection shall be coated thoroughly with a pipeline grade mastic coating.

4.4 CONDUIT

a. Below grade dc cables with the exception of vertical anode leads shall be installed in rigid PVC conduit a minimum of 8" (200 mm) below grade.

b. Above grade dc wiring shall be installed in rigid conduit.

4.5 SAW SLOTS

a. Saw slots shall only be used in concrete pads to accommodate singular anode cable and zinc reference electrode cable.

b. Saw slots shall be a minimum of 3/8" (18 mm) wide and 3" (75 mm) deep.

c. Saw slots shall be backfilled flush to the existing pad with non-shrink cement grout.

4.6 ZINC REFERENCE ELECTRODE

a. A zinc reference electrode shall be installed midway between tanks at a depth halfway between the top and bottom of the tanks.

b. Zinc reference electrode shall be installed complete with its container and backfill.

c. Do not lower zinc reference electrode into hole by the reference electrode cable.

4.7 RECTIFIER

a. Rectifier shall be located within the electrical utility room. If this is not possible an outside location is acceptable providing it is near the ac supply panel and does not interfere with vehicular or pedestrian traffic.

b. The ac supply to the rectifier shall be through a separate circuit breaker in the main electrical panel which shall be locked in the 'ON' position and should be labelled accordingly.

4.8 CABLE AND CONDUIT EXCAVATIONS

a. All conduit trenching shall be a minimum of 3" (75 mm) wide and 8" (200 mm) deep.

b. All trenching and excavations shall be backfilled to the level of existing fill and fully compacted.

c. Conduit trenches shall be marked with a utility marker tape and paved with asphalt to Owner's specification.

5.0 - INSPECTION AND COMMISSIONING

5.1 GENERAL

a. All works shall be inspected and tested prior to backfilling.

b. All works in this section shall be carried out by a Corrosion Specialist or his authorized representative.

5.2 ANODE SHORT CIRCUIT TEST

a. The resistance of each anode to the nearest tank structure shall be measured with a Vibroground 263 or equivalent to ensure that the anode is not in contact with the structure. An ohm meter or 'Megger' is not an acceptable device for these measurements, since the resistance should be a fraction of an ohm. The results shall be recorded in Table No. 4 and submitted with the final report.

5.3 CABLE INSPECTION

All positive and reference anode cables shall be inspected to ensure that all nicks and cuts in the cable insulation have been repaired as required in Section 4.3d.

5.4 RECTIFIER COMMISSIONING

a. One structure lead shall be connected to the rectifier negative power terminal and one to the rectifier negative sense terminal or negative terminal of indicating meter.

b. The rectifier negative shall be bonded to the station electrical ground.

c. All positive header cables shall be connected to the rectifier positive power terminals.

d. The zinc reference electrode cable shall be connected to the indicating meter positive terminal or the rectifier positive sense terminal.

e. Before energizing the rectifier Section 4.1 and 5.5b must be completed.

f. The output of the rectifier shall be set to its lowest voltage level and the rectifier switched on.

g. Output voltage shall be increased gradually as per rectifier manufacturer's instructions until all tank potentials with respect to the respective reference electrodes are a minimum of -1000 mV. with respect to $Cu:CuSO_4$. If these potentials cannot be obtained instantaneously the power supply may be left operating at a current output equal to or greater than the total current summation of Section 2.2.

h. The output monitoring circuits and the constant current control circuit shall be energized with the "minimum current setting" to be set at the current required to achieve a minimum tank-to-soil potential of -1000 mV. as in Section 5.4g.

5.5 STRUCTURE-TO-SOIL MEASUREMENTS

a. Structure-to-soil measurements must be taken using a $Cu:CuSO_4$ reference electrode and a voltmeter having an input impedance suitable for accurate measurements with the reference electrode in contact with concrete and asphalt. In all cases a minimum 1/2" (12 mm) diameter hole must be drilled through the asphalt or concrete and a water solution poured into the hole to provide an electrolytic bridge between the soil and reference electrode. Alternatively a larger hole may be drilled to allow the reference electrode to be placed directly on the soil surface.

b. Prior to energizing the rectifier a "Static" survey shall be conducted on the tankage. The survey shall be conducted in the following manner:

(i) The potential of the tanks with respect to the zinc reference electrode shall be measured.

(ii) The potential of each tank shall be measured with reference to a $Cu:CuSO_4$ electrode. Three potentials shall be measured directly over each tank as indicated in Table No. 2.

(iii) The measured potentials shall be recorded on Table No.2.

c. After 30 days but before 6 months of continuous rectifier operation a 'Post-Installation' survey shall be performed as follows:

(i) The rectifier dc voltage and current elapsed time hours of operation and control parameters shall be noted.

(ii) The rectifier output current shall be cyclically interrupted such that the rectifier 'ON' period is a minimum of twice the time of the rectifier 'OFF' period where total ON/OFF cycle time shall not exceed 30 seconds.

(iii) Potentials shall be recorded both with the rectifier 'ON' and 'OFF' in an identical manner as described in Section 5.5b steps (i) through (iii).

(iv) The measured potentials shall be recorded on Table No. 2.

5.6 REPORT

a. A written report shall be submitted by the Contractor on the completion of each installation and shall be signed by a Corrosion Specialist.

b. The report shall declare that the tanks are cathodically protected. The minimum criterion for protection of tanks shall be -850 mV. with the rectifier instantaneouly 'OFF' with reference to a $Cu:CuSO_4$ electrode. In some situations of high soil resistivity the design current will be unobtainable because the rectifier output voltage limit may be 24 V and the minimum potential of -850 mV may not be achieved. The rectifier does not require replacement with a higher voltage unit as long as all potential measurements satisfy the 100 mV criterion of Section 6.3.3 of Recommended Practice RP-02-85, latest revision, as published by the National Association of Corrosion Engineers, P.O. Box 218340, Houston, Texas 77218.

c. 'Contractor' must supply 'As-Built' drawings showing cathodic protection plan and electrical schematic on a 'c' size drawing.

d. The report shall contain the following:

(i) Electrical Continuity Test Results (Table No. 3)

(ii) Individual anode-to-tank resistances. (Table No. 4).

(iii) 'Static' potential survey measurements. (Table No.2)

(iv) 'Post-Installation' potential survey measurements c/w rectifier output voltage and current and indicating meter readings (Table No.2).

e. The cathodic protection system location and operating parameters shall be reported to the local electrolysis committee by the 'Owner'. Location of the local electrolysis committee chairman can be obtained from the National Association of Corrosion Engineers, P.O. Box 218340, Houston, Texas 77218 (Phone 713-492-0535).

PART 6.0 - MAINTENANCE

a. The rectifier output voltage and current and the reading of the monitoring meter shall be recorded weekly.

b. The tank owner shall be notified should the rectifier status indicating lights denote a problem or the controlled parameter (e.g. current or potential) change is greater than 10% from the normal operating conditions.

c. A cathodic protection survey shall be conducted by a Corrosion Specialist or his authorized representative to ensure continued operation of the system as designed the year immediately following installation and every two years thereafter.

TABLE NO. 2 POTENTIAL SURVEY RESULTS

TANK NO.	REFERENCE ELECTRODE LOCATION	STATIC	POST-INSTALLATION	
		(mV)	RECTIFIER ON (mV)	RECTIFIER OFF (mV)
1	VENT			
	CENTRE			
	FILL			
2	VENT			
	CENTRE			
	FILL			
3	VENT			
	CENTRE			
	FILL			
4	VENT			
	CENTRE			
	FILL			
5	VENT			
	CENTRE			
	FILL			
6	VENT			
	CENTRE			
	FILL			
INDICATING METER	REF. 1			
	REF. 2			
	REF. 3			
RECTIFIER OUTPUT:		VOLTS / AMPS		

NOTES: DATE:

NOTES:

1. "ELECTRODE" REFERS TO A CU:CUSO4 REFERENCE ELECTRODE.
2. VENT AND FILL ARE ASSUMED TO BE AT OPPOSITE ENDS OF TANKS.

TABLE NO. 3 - ELECTRICAL CONTINUITY TEST RESULTS

REFERENCE ELECTRODE LOCATION: _____

STRUCTURE	POINT OF CONNECTION	POTENTIAL

DATE:

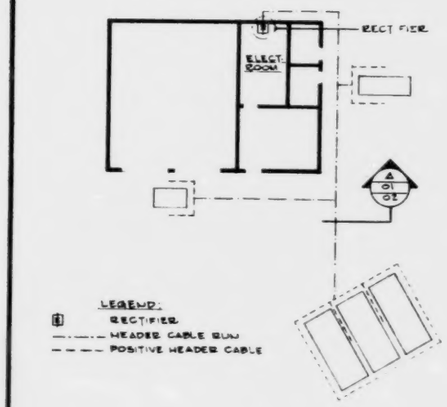
NOTES:

TABLE NO. 4 ANODE SHORT CIRCUIT TEST RESULTS

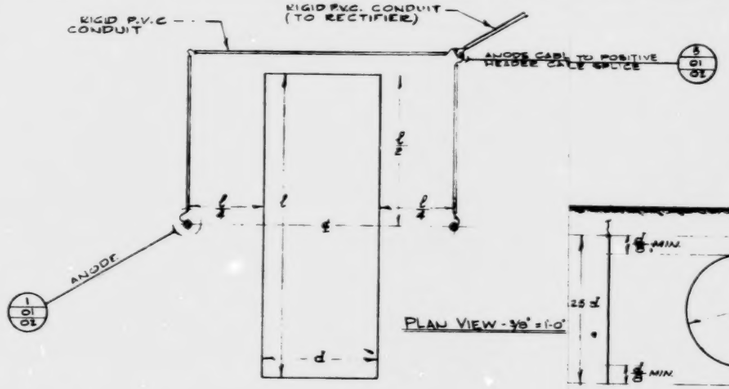
ANODE NO.	TANK NO.	RESISTANCE (OHMS)

DATE:

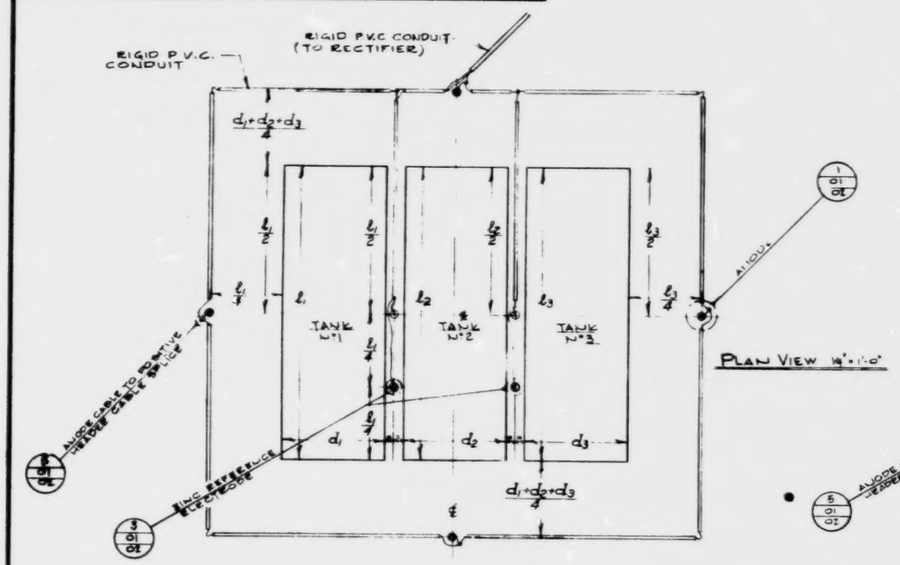
NOTES:



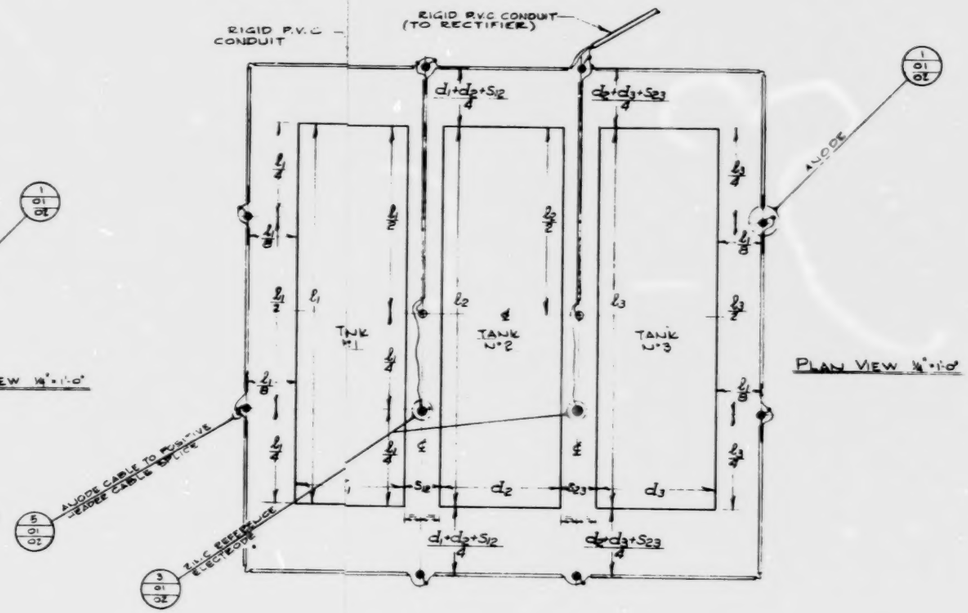
TYPICAL PLOT PLAN N.T.S.

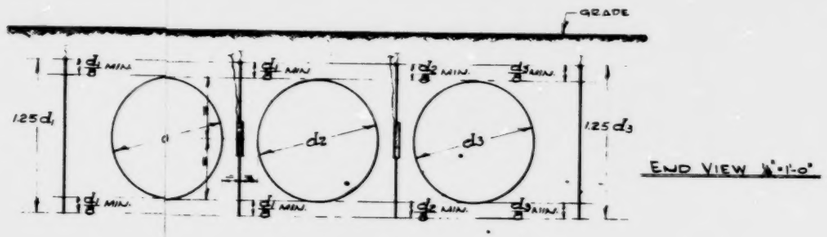

RIGID P.V.C. CONDUIT
RIGID P.V.C. CONDUIT (TO RECTIFIER)
ANODE CABLE TO POSITIVE HEADER CABLE SPLICE
ANODE
PLAN VIEW - 3/8" = 1'-0"
GRADE
END VIEW - 3/8" = 1'-0"

TYPICAL ARRANGEMENT FOR SINGLE TANK OF 1,000 I.G. (5,001) CAPACITY OR LESS AND FOR ALL U.L. 603.1M TANKS



TYPICAL ARRANGEMENT FOR 3 TANKS OF 3,000 I.G. (15,000 l) CAPACITY OR LESS





TYPICAL ARRANGEMENT FOR 3 TANKS OF 5,000 I.G. (25,000 l) CAPACITY OR LARGER

MATERIALS LIST

ITEM	DESCRIPTION	
1.	0.092"ø PLATINUM-CLAD NIOBIUM ANODE WIRE	
2.	RECTIFIER TYPE ____ VOLT ____ AMP	
3.	ZINC REFERENCE ELECTRODE	
4.	AWG N° 8/7 STR. RWU-90 RED CABLE	
5.	AWG N° 12/7 STR. RWU-90 RED CABLE	
6.	AWG N° 8/7 STR. RWU-90 BLACK CABLE	
7.	AWG N° 12/7 STR. RWU-90 WHITE CABLE	
8.	3/4"ø RIGID P.V.C. CONDUIT	
9.	1"ø RIGID P.V.C. CONDUIT	
10.	RIGID CONDUIT	
11.	NEOPRENE TAPE	
12.	GROUND CLAMP	
13.	HEAT SHRINKABLE TUBING	
14.	INSULATING PAD	
15.	COPPER CONNECTOR	
16.	CALCINED PETROLEUM COKE BREEZE	
17.	MASTIC COATING	
18.	POLYETHYLENE TAPE	

DETAIL SYMBOL IDENTIFICATION

1/01/01 — DETAIL NUMBER
— SUFFIX NUMBER OF DRAWING DETAIL TAKEN FROM
— SUFFIX NUMBER OF DRAWING DETAIL SHOWN ON

NOTE: ALL ANODE LOCATION & LENGTH DIMENSIONS ARE RELATIVE TO TANK DIMENSION & SPACING.

MARK	REVISION	DATE	DR.	CK.
2	CORE ANODE DELETED. ZINC REF. ADDED TO 3 TANKS.	JUNE 23/78	AHK	
1	LEGEND ADDED TO PLOT PLAN. MATERIALS LIST REVISED	APR. 10-78	BV	

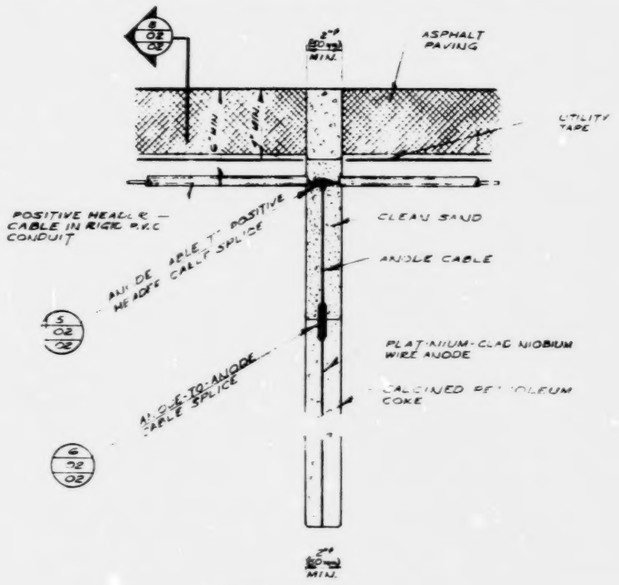
DESIGNED BY: | APPROVED BY:

CORROSION SERVICE COMPANY LIMITED
Corrosion Engineering Specialists
Winnipeg Sarnia TORONTO Montreal Moncton

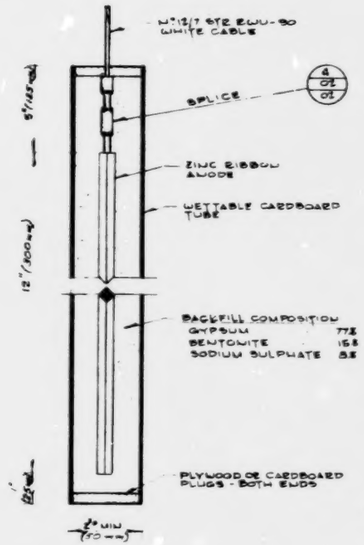
P.A.C.E.

Cathodic Protection Plan

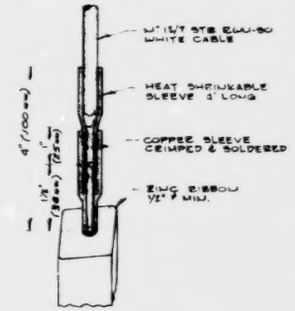
SCALE:	AS SHOWN	CONTRACT NUMBER:	CJ-01-86-4024-01
DATE:	NOV. 20/1977	DWG. No.	D-1448-01
DRAWN BY:	BV	REV	2
CHECKED BY:	R. Cummow		



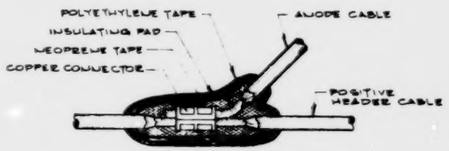
DETAIL 1/01/02 N.T.S. TYPICAL ANODE



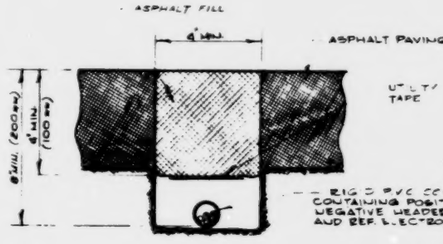
DETAIL 3/01/02 N.T.S. ZINC REFERENCE ELECTRODE



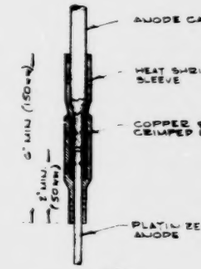
DETAIL 4/01/02 N.T.S. SPLICE



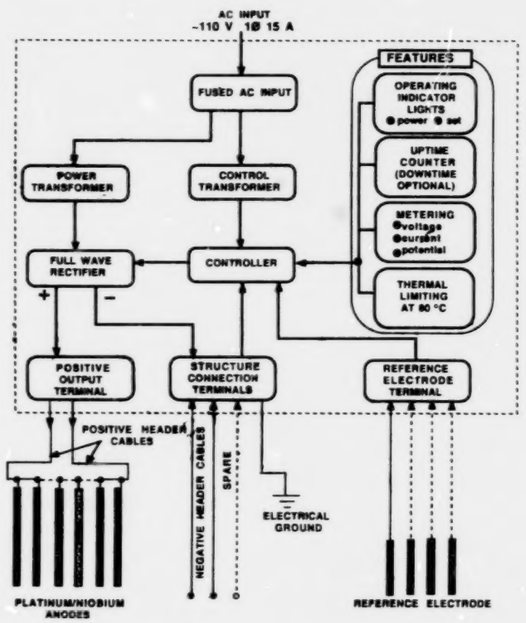
DETAIL 5/01/02 5/02/02 N.T.S. ANODE CABLE-TO-POSITIVE HEADER CABLE SPLICE



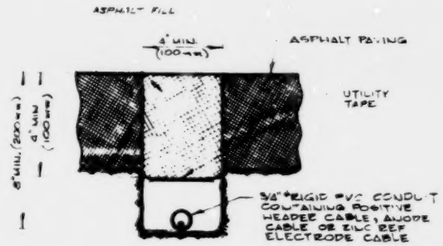
SECTION 4/01/02 N.T.S



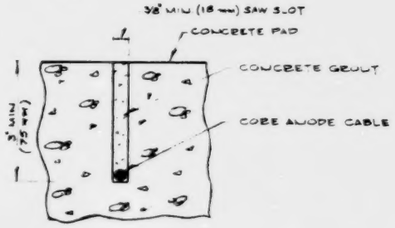
DETAIL 6/02/02 N.T.S. ANODE-TO-ANODE CABLE SPLICE



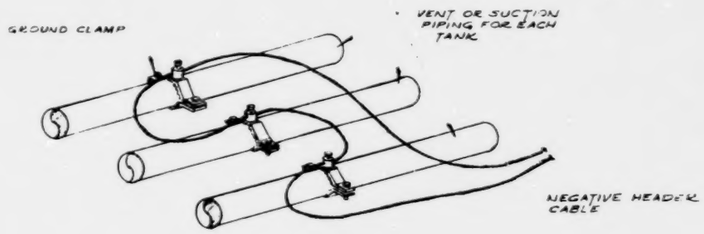
PAGE 142 TYPICAL ELECTRICAL SCHEMATIC


ASPHALT FILL
4" MIN (100mm)
ASPHALT PAVING
UTILITY TAPE
8" MIN (200mm)
4" MIN (100mm)
¾" RIGID PVC CONDUIT CONTAINING POSITIVE HEADER CABLE, ANODE CABLE OR ZINC REF ELECTRODE CABLE

SECTION 5/01/02 N.T.S



ALTERNATIVE CABLE INSTALLATION FOR ANODES & ZINC REFERENCE ELECTRODE WHERE CONCRETE PAD EXISTS OVER TANKS



TYPICAL NEGATIVE CONNECTION N.T.S

MARK	REVISION	DATE	DR.	CK.
4	UTILITY TAPE ADDED	DEC 4-86	ANG	
3	DETAIL #2 DELETED, SCHEMATIC ADDED, WEST CONN RELOCATED	JUNE 23-86	ANG	
2	REINFORCING BAR REMOVED FROM SEC. A&B ASPHALT FILL HAS CONC. FILL NOTE ADDED	JULY 20-78	ANG	
1	GENERAL REVISIONS	APR 18-78	BV	

DESIGNED BY: APPROVED BY:

CORROSION SERVICE COMPANY LIMITED
Corrosion Engineering Specialists
Winnipeg Sarnia TORONTO Montreal Moncton

P.A.C.E.

Cathodic Protection Details and Electrical Schematic

SCALE:	N.T.S.	CONTRACT NUMBER:	CJ-07-86-4024-P
DATE:	NOV. 20/1977	DWG. No.	REV.
DRAWN BY:	BV	D-1448-02	4
CHECKED BY:	RC Gunnow		